

A NEW PERMIAN AND UPPER CARBONIFEROUS (?) SUCCESSION NEAR WOODSREEF, N.S.W., AND ITS BEARING ON THE PALAEO- GEOGRAPHY OF WESTERN NEW ENGLAND

ILFRYN PRICE*

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Synopsis

A fossiliferous Permian arenite (Ironbark Creek Arenite) occurs immediately west of the Peel Fault near Woodsreef. This overlies, with apparent conformity, a sequence containing both volcanic derived sediments (typical of the Carboniferous rocks of the region) and conglomerates similar to those in other Permian units in the Peel Fault Zone. It is suggested that this is a new Upper Carboniferous/Lower Permian sequence (Crow Mountain Creek beds). These two new units help confirm McKelvey and Gutsche's (1969) model for the Lower Permian palaeogeography of Western New England involving a tectonic high east of the Peel Fault. They provide more tentative support for Campbell's (1969) suggestion of a similar feature in the Upper Carboniferous. The development of a non-volcanic tectonic high east of the Peel Fault began before volcanic activity in the region had ceased and prior to the only folding episode in the area.

INTRODUCTION

It is nearly sixty years since W. N. Benson (1913) first demonstrated the importance of the tectonic boundary marked by the "Great Serpentinite Belt of N.S.W.". This boundary, now recognized as the Peel Fault, separates the eugeosynclinal "Central Complex" of the New England Geosyncline from the more gently deformed and broadly miogeosynclinal "Western Belt of Folds and Thrusts" (Voisey, 1959).

During 1970 the author undertook a detailed examination of some 80 km² of this terrain in the vicinity of the village of Woodsreef, some 17 km east of Barraba, a town 540 km north-west of Sydney. Evidence from this study, particularly from Upper Palaeozoic sediments west of the Peel Fault, provides a basis for examining aspects of the palaeogeography of western New England. This discussion is confined to the successions either side of the serpentinite body (Fig. 1) which obscures the Peel Fault around Woodsreef. These comprise an eastern succession of radiolarian jaspers, basic lavas and argillites and a western succession of conglomerates, arenites and mudstones.

Benson (1913) included the eastern succession in his Woolomin Series. Proud and Osborne (1952) considered the same rocks belonged to Benson's overlying Tamworth Series, but advanced no evidence for their revised interpretation. Lithologically, the eastern succession appears to belong to the Woolomin Beds (Crook, 1961a), within which identical associations are now placed elsewhere along the Peel Fault. Palaeontological data from the Woolomin Beds are limited to a few Silurian fossils (Lusk, 1963; R. L. Hall, pers. comm., 1970). The age of these rocks exposed around Woodsreef remains uncertain, but is most probably similar.

Correlation of the western succession with the stratigraphy of the central and western zones of the Western Belt of Folds and Thrusts is not so straightforward due to the relative structural complexity close to the Peel Fault together with the lack of palaeontological control and significant marker horizons. Benson (1913) allocated the sequence to his Lower Carboniferous "Burindi Series", whilst Proud and Osborne (1952) preferred to refer the bulk of it to Benson's underlying "Barraba Series". They restricted the Burindi Series to a narrow fault-bounded strip immediately adjacent to the Peel Fault. No such distinction was recognized by Leslie (1963), who placed all these rocks in the Lower Carboniferous Namoi Formation, bringing the stratigraphic nomenclature into line with that now in use farther west.

* Sedgwick Museum, Downing St., Cambridge CB2 3EQ, England.

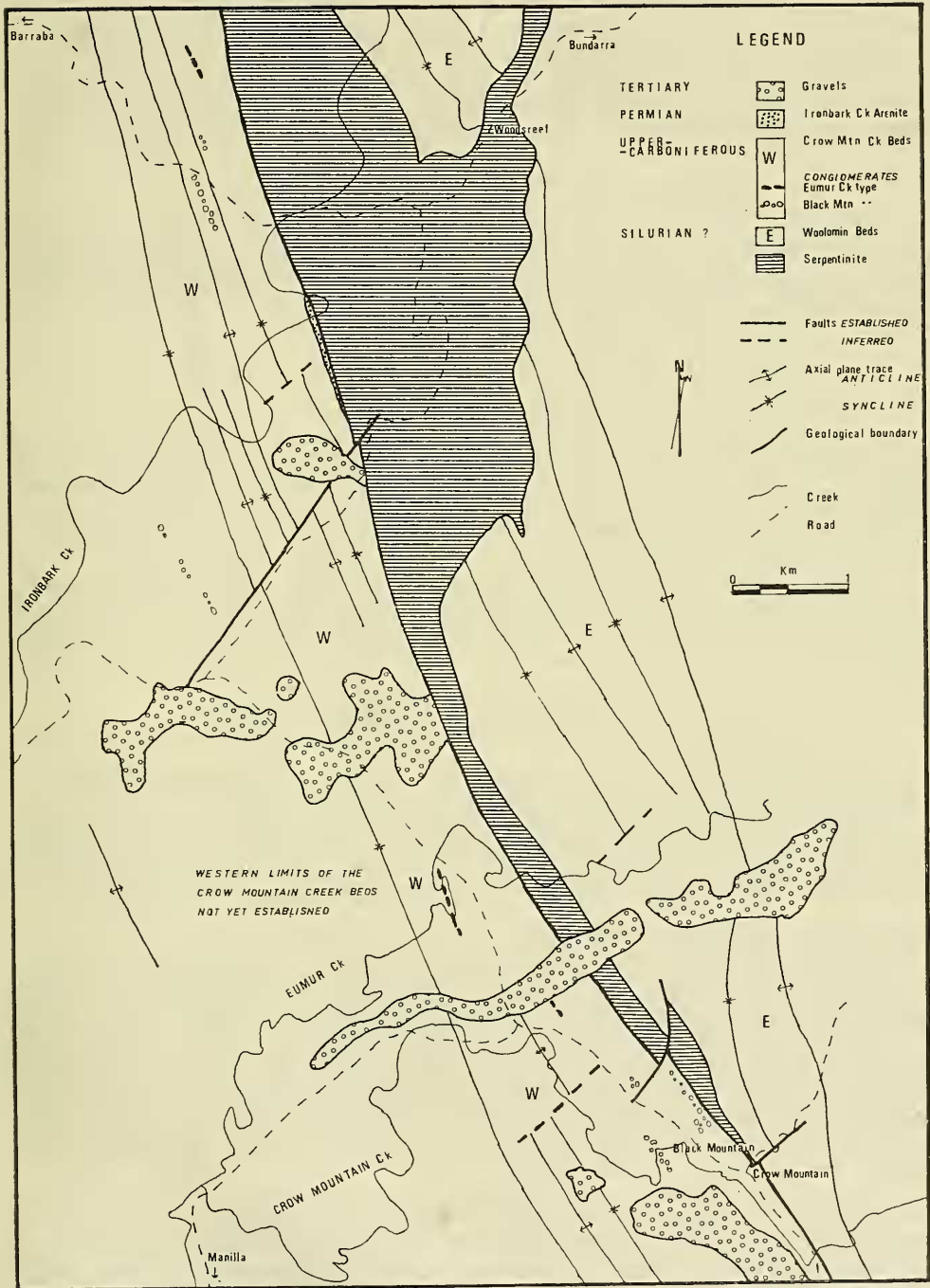


Fig. 1. Geological map of the Woodsreef area.

Further revision is justified. A new fossiliferous Permian arenite is described below. It is proposed that this be called the "*Ironbark Creek Arenite*". The remainder of the western succession cannot easily be correlated with known stratigraphic units in the region. In view of the uncertainty as to their exact age, all these rocks have been placed in a new unit, the "*Crow Mountain Creek beds*". This is suggested merely as an informal unit owing to the lack of a type section or an exact age for the rocks included therein.

STRATIGRAPHY OF THE WESTERN SUCCESSION

(1) *The Ironbark Creek Arenite*

The type section of this new unit is located on the southern bank of Ironbark Creek 0.8 km downstream of the bridge on the Barraba-Woodsreef road (U.N.E. Fossil Locality L891). Four spiriferids identified to date from the type locality (F10594-F10609 U.N.E. Fossil Catalogue) are:

- Pseudosyrinx* sp. nov.;
- Sulcifica* cf. *stutchburii* (Etheridge, 1892);
- Trigonotreta* cf. *stokesi* (Koenig, 1825);
- Ingelarella* ? *ovata* Campbell, 1961.

All these identifications were based on descriptions provided by Armstrong (1969). His time ranges suggest a Sakmarian or perhaps Lower Artinskian age for the fauna. In addition Dr. B. Runnegar (pers. comm., 1971) identified *Deltopecten* sp. from the type locality and suggested the fauna correlated with Dickens' (1968) Allandale fauna.

The new name is suggested for the arenite in which these fossils are found. It is tectonically overlain by serpentinite, whilst its lower limit is taken as the top of underlying mudstones. The Ironbark Creek Arenite becomes the third established occurrence of Permian sediments from the Peel Fault Zone. Others are:

- (i) The Andersons Flat Beds (Crook, 1961*b*) near Nundle;
- (ii) Unnamed fossiliferous Permian sediments north-east of Attunga (Hall, 1963).

The Ironbark Creek Arenite is probably a chronostratigraphic equivalent of the second of these two units (Runnegar, pers. comm., 1971).

Also, Johnston (1968) described Upper Carboniferous or Lower Permian rocks overlying fossiliferous Namoi Formation near Cobbadah, 20 km north of Woodsreef along the Peel Fault, but no reliable age has yet been obtained.

(2) *The Crow Mountain Creek Beds*

This informal name is proposed in order to simplify discussion of the palaeogeographic implications of the rocks in question. In this section reasons are outlined for not correlating these rocks with the known succession of the region.

Apart from rare worm burrows and crinoid ossicles, the only fossils found in the Crow Mountain Creek beds are a single rugose coral and a brachiopod fragment, both from a small limestone lens at the ford on the road into Black Mountain Homestead. These could not be positively identified but both Drs. B. Runnegar and J. Roberts suggested that they had a Carboniferous rather than a Devonian or Permian aspect.

Later in this paper two petrographic types of conglomerate in the Crow Mountain Creek beds will be described. One type contains abundant clasts of radiolarian jasper, a feature of Permian sediments along the Peel Fault (McKelvey and Gutsche, 1969). With the exception of these conglomerates the terrigenous sediments are all volcanogenic and resemble known Lower Carboniferous marine sediments in the Western Belt of Folds and Thrusts. The second conglomerate type has a volcanic clastal assemblage very similar to that found in the Middle (Upper ?) Carboniferous Rocky Creek Conglomerate, a terrestrial unit occurring

farther west. Continuous exposure across beds of the jasper-bearing conglomerates shows that they are conformable with and not faulted into the volcanic-derived rocks.

The Ironbark Creek Arenite overlies mudstone of the Crow Mountain Creek beds with apparent conformity and no evidence of shearing along the contact. Whilst the fossiliferous unit might be a fault sliver in the Peel Fault Zone, there is no direct evidence of this, and at present it appears that the Permian arenite has a conformable association with mudstones of the type found throughout the Crow Mountain Creek beds.

Thus the western succession (excluding the Ironbark Creek Arenite) has affinities with both the Carboniferous and Permian of the surrounding region. Rocks of both ages may be present. The petrographic similarities with the Rocky Creek Conglomerate and the apparent conformity with the Ironbark Creek Arenite suggest that rocks of Upper Carboniferous age exist in the Woodsreef area. Furthermore, it appears that the jasper-bearing conglomerates are older than their petrographic equivalents in the Permian sediments along the Peel Fault to the south.

There is sufficient evidence to say that these rocks do not belong in the Namoi Formation as suggested by Leslie (1963). Deformation prevents the definition of a type section, and increases the difficulty in erecting a formal stratigraphic unit. Further work should establish the extent of the Crow Mountain Creek beds. At present their western contact with older sediments is thought to coincide approximately with a fold axis about 1.6 km west of the Peel Fault (Fig. 1). Jasper-bearing conglomerates have not been found west of this line. The fold axis may be faulted since it also marks a change in the intensity of folding. A representative section of the Crow Mountain Creek beds may be seen along Crow Mountain Creek between Crow Mountain and this fold axis.

GENERAL PETROGRAPHY

(1) *Introduction*

The Woolomin Beds comprise a sequence of jaspers, basic lavas and argillites. Very low-grade metamorphism has affected the sequence, leading to extensive recrystallization of the jaspers and, in suitable lithologies, the development of chlorites, white micas, albite, epidote, prehnite and pumpellyite. Radiolaria are rarely visible in the jaspers but they are abundant in less recrystallized specimens taken from xenoliths in the serpentinite.

Mudstones form the bulk (50–60%) of the Crow Mountain Creek beds. For present purposes they are unimportant and only the palaeogeographically significant arenites and conglomerates will be discussed here. The small limestone lens mentioned in the preceding section is the only limestone known in the unit to date. Two petrographic varieties of conglomerate, also recognizable in hand specimen, are found in the Crow Mountain Creek beds. They have been designated as types in order to describe and contrast them conveniently. Before so doing it must be emphasized that neither type is thought of as representing a particular stratigraphic marker and no correlation can be made between individual beds of either type.

(2) *Conglomerates of the Black Mountain type*

Type locality: In Crow Mountain Creek 75 m below the ford on the road to Black Mountain Homestead.

Lithology: Medium- to coarse-grained polymictic orthoconglomerates with well rounded clasts in a silty or arenaceous matrix of distinctly different grainsize.

Principal constituents of clasts: Andesitic volcanics and granodiorites.

Occurrence: As lenses throughout the area (Fig. 1), but more frequent in the south. These lenses are usually isolated within mudstones but in one instance the conglomerates form the basal bed to a massive arenite.

Discussion: The most extensive exposure occurs at the type locality, where a conglomerate lens has a maximum thickness of 12 m and a range in clast diameter from 10 to 50 cm. Many clasts are ellipsoidal, but no preferred orientation of their long axes could be recognized. The only indicator of palaeocurrent directions in these conglomerates is the northward decrease in abundance and clast size, suggesting a source in a very generally southerly direction.

Most clasts belong to an assemblage of andesitic lavas and ash-flow tuffs. Tonalites and granodiorites are common. The latter exhibit occasional granophyric intergrowths. They also have up to 1% of disseminated chalcopyrite. Less common clasts are fine-grained protoquartzites (in the sense of Pettijohn, 1957). These are distinctive due to their accessory constituents—zircon, muscovite, magnetite and plagioclase. Petrologically and texturally, they are very similar to quartzite clasts from the Rocky Creek Conglomerate described by Yeates (1970). This latter unit also has igneous clasts closely resembling those of the Black Mountain type conglomerates.

(3) *Conglomerates of the Eumur Creek type*

Type locality: In Eumur Creek 250 m west of the Barraba-Crow Mountain road.

Lithology: Fine- to medium-grained polymictic orthoconglomerates with sub-rounded irregularly shaped clasts and no sorting between clasts and matrix.

Principal constituents of clasts: Radiolarian jaspers and basic lavas.

Occurrence: As narrow beds at three widely separated localities (Fig. 1) with two beds at one locality and one at each of the others.

Discussion: As before, it is the type locality of these conglomerates which provides the most extensive exposure. Two beds of conglomerate outcrop, each about 2 m thick. These are separated by 1 m of mudstone. Both beds can be traced over a strike length of some 400 m, giving them a tabular or blanket form in contrast to the more lensoidal shape of the Black Mountain type conglomerates.

The only noticeable difference between jasper clasts in these conglomerates and the jaspers of the Woolomin Beds is the recrystallization and assumed destruction of Radiolaria in the latter. Basic lavas in clasts are texturally and petrologically similar to lavas east of the Peel Fault but have not been metamorphosed. Other materials in clasts are mudstones (including banded varieties), siltstones and rare intermediate lavas. One oolitic limestone fragment was noted in a specimen from the type locality.

The conglomerates are all poorly sorted with a range in grain size from silt grade material to a maximum diameter of 2 cm. The coarsest clasts are found at the type locality. Graded bedding is visible in the most southerly occurrence.

In the section at the type locality arenites, striking parallel to the conglomerate bed, crop out a few metres above and below them. Eumur Creek cuts the type horizon of the conglomerates in two places (Fig. 1). The same relationship with the arenites may be seen in both outcrops, indicating conformable interbedding of the conglomerates with the arenites.

(4) *Arenites in the Crow Mountain Creek beds*

Two varieties are recognizable in outcrop. These are, firstly, thinly interbedded arenites in mudstones, and secondly, thick massive arenites. Individual beds of the first variety range from 1 to 20 cm in thickness, whilst the massive arenite beds are usually at least 10 m thick. Interbedding with arenites occurs over varying thicknesses of mudstones. These beds often show

graded bedding and typical turbidite sole markings. Intraformational mudstone detritus is a less common feature of the massive arenites.

The rocks range from tuffs (waterlain and normally redeposited) through feldspathic arenites with a detrital pyroclastic or lithic volcanic component to volcanic derived lithic arenites. A greater abundance of pyroclastic material, principally devitrified glass and shards, is a feature of the interbedded arenites which are invariably the more tuffaceous of the two groups. Although still derived from a volcanic terrain, the massive arenites have a much greater lithic contribution. Pumice and volcanic glass fragments are the commonest lithic components, but fine-grained intermediate lavas, quartzites, mudstones, granophyric fragments and occasional carbonates are also present. There is a large variation in the relative abundance of feldspar and lithic material, whilst the quartz content is uniformly low. No arenaceous equivalent of the Eumur Creek conglomerates has been found. Burial metamorphic assemblages are absent.

(5) *The Ironbark Creek Arenite*

This is a massive unit much thicker (40 m maximum) than similar lithologies in the Crow Mountain Creek beds. Two other mesoscopic features distinguish it from the latter, namely:

- (i) Abundant fossils mainly single brachiopod valves;
- (ii) Dispersed, well-rounded clasts with a flattened ellipsoidal shape. Some have one flattened face, giving a hemi-ellipsoidal shape but with a smoothed and rounded edge.

Both these features are more prominent in the centre of the bed. At the type locality this central zone also contains a 15 cm bryozoan horizon.

The Ironbark Creek Arenite is a lithic labile arenite with a low feldspathic content. Quartz is more abundant than feldspar. The lithic contribution is not dominated by volcanic material, nor does the quartz appear to be of volcanic origin. Fine quartzose sediments are the principal lithic components, but they contain no radiolarian tests. Metaquartzite, mudstones and rare intermediate and basic lavas and ash flow tuffs complete the lithic assemblage.

PROVENANCE AND SEDIMENTATION OF THE WESTERN SUCCESSION

Arenites in the Crow Mountain Creek beds indicate an environment in which arenaceous volcanogenic debris periodically supplemented the prevailing mudstone sedimentation. Redeposited pyroclastic material, as evidenced by the arenites interbedded with mudstones, is the more common manifestation of this interruption. Graded bedding in, and cut-and-fill structures at the base of the thin arenite beds suggest they are turbidites (*cf.* Kuenen, 1964). Mass movement of poorly consolidated pyroclastic debris would be aided by the steep gradients and tectonic instability of an active volcanic terrain. The massive arenite beds are believed to represent the erosion of the better consolidated parts of such a terrain. Thus arenaceous sediments in the Crow Mountain Creek beds are interpreted as indicating the existence of a volcanic distributive province.

In contrast to the arenites, the conglomerates show two very different source areas; one chiefly volcanic and the other dominated by sedimentary rocks. Furthermore, material from each of these sources underwent very different sedimentation processes, a conclusion borne out by the textural differences between the two conglomerates.

The Black Mountain type conglomerates were probably derived from the same volcanic distributive province as the arenites with the inclusion of a sub-volcanic plutonic component. Accommodating fine-grained protoquartzites into any model for a volcanic distributive province is difficult. As was mentioned above, identical clasts occur in the Rocky Creek Conglomerate to the west. It

may be that the Black Mountain type conglomerates were reworked from this piedmont deposit. Without directional indicators it seems reasonable to assume that this volcanic province lay to the west since this is the direction suggested by all the vectorial evidence available for volcanic derived sediments in the Western Belt of Folds and Thrusts (McKelvey, pers. comm., 1970).

The Eumur Creek type conglomerates, in addition to their singular provenance, present a peculiar sedimentation problem. They are restricted in occurrence and are not associated with petrographically similar sands. Moreover, they are interbedded with volcanic derived arenites, indicating the close juxtaposition in time of two very different source areas. The poor sorting and low clastal sphericity of these conglomerates imply rapid transport from a nearby source area with only a limited period of deposition.

The only petrographically compatible source for the Eumur Creek type conglomerates is to the east from the Woolomin Beds. This implies a tectonic high east of the present line of the Peel Fault. This need not have formed a continuous land mass; indeed, the limited extent of the conglomerates suggests it was discontinuous and only intermittently exposed to erosion. Such a situation also helps to explain the absence of arenaceous sediment derived from the same source area. Brief rapid erosion of a nearby terrain need not have yielded any detritus other than the poorly sorted material found in the Eumur Creek type conglomerates.

The dispersed ovoid clasts in the Ironbark Creek arenites must be explained. No local or regional evidence supports a glacial rafting hypothesis. Organic rafting explains neither their shape nor frequency. A more tenable hypothesis is that this unit represents an extremely shallow water sedimentary environment with the extraneous pebbles introduced by tidal currents. Smoothing of one face on some pebbles does not seem impossible in such a situation. Thus the Ironbark Creek Arenite is envisaged as indicating either a littoral or a near shore shoaling facies. Biogenic debris supports this hypothesis.

It is hard to link the petrography of the Ironbark Creek Arenite with either of the distributive provinces established for the Crow Mountain Creek beds. Elements of both are present in the rock. However, in a broad sense its predominantly sedimentary/metamorphic provenance links the arenite to the eastern distributive province.

Worm tracks in the mudstones, occasional crinoid ossicles in the arenites and the turbidite features of many of them show that the Crow Mountain Creek beds are marine. It is impossible to estimate the order of depth of the water in which they were deposited, but it is clear that the mudstone/arenite sediments represent deeper water sedimentation than the Ironbark Creek Arenite. A comparison of these two units indicates a shallowing of the sedimentary basin. This presumably accompanied the growth of the high to the east so that littoral conditions prevailed on its periphery.

THE WOODSREEF AREA IN A REGIONAL PALAEOGEOGRAPHIC FRAMEWORK

Recently, two palaeogeographic reconstructions of Western New England have been proposed (Fig. 2) by Campbell (1969) for the Carboniferous and McKelvey and Gutsche (1969) for the Lower Permian. In Campbell's model for the Upper Carboniferous much of Central New England is occupied by an emergent tectonic high which he termed the "New England Arch". A rather similar feature was suggested by McKelvey and Gutsche. They show a broad tectonic land between the Peel Fault and a line from Ashford through Inverell to Armidale. Permian sediments in New England are only known from either side of this block. The foregoing discussion confirms the existence of such an uplifted land area.

During this study the Upper Carboniferous or Permian sediments at Cobbadah (Johnston, 1968) were re-examined. They comprise a thick unit of arenites and conglomerates overlying fossiliferous Lower Carboniferous rocks with apparent conformity and show the supracrustal provenance characteristic of the Permian sediments along the Peel Fault. Orthoconglomerates are identical to the Eumur Creek type conglomerates and to the known Lower Permian conglomerates farther south at Attunga (Hall, 1963) which McKelvey and Gutsche used in their palaeogeographic model.

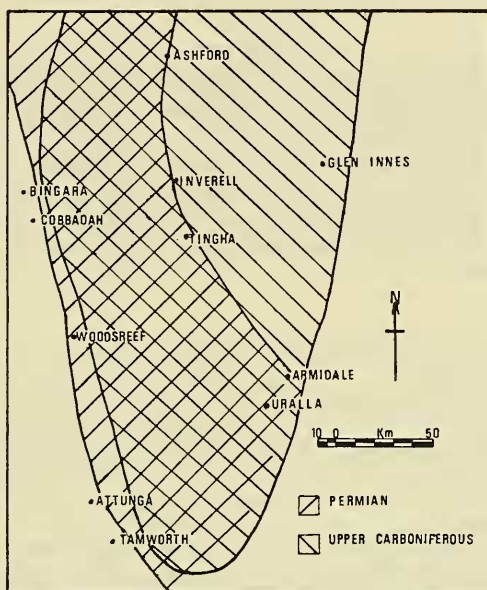


Fig. 2. The approximate locations of the Upper Carboniferous and Lower Permian land masses in New England suggested respectively by Campbell (1969) and McKelvey and Gutsche (1969).

Whilst the Eumur Creek type conglomerates and those at Cobbadah fit this model, the former are definitely older than the Ironbark Creek Arenite, and they are part of a succession in which the bulk of the clastic sediments have a volcanic provenance. Thus the New England Arch must have been initiated before volcanogenic sedimentation (presumably from the west) had finished. It seems likely that, east of Woodsreef at least, a land mass was intermittently exposed as early as the Upper Carboniferous. This may mark the first appearance of such a block prior to its more extensive development in the Lower Permian.

If the rocks at Cobbadah derived from the east are in fact Upper Carboniferous, as seems probable by the absence of palaeontological evidence, then it would imply the more extensive development northwards of the New England Arch. Farther south at Attunga the first known indication of this structure is in the Lower Permian, at which time a shallow water environment existed at Woodsreef and perhaps marine sedimentation had finished around Cobbadah.

Until palaeontological proof of the age of the Crow Mountain Creek beds or the similar rocks near Cobbadah is forthcoming, it cannot be said that they definitely confirm Campbell's model for the New England Arch. However, they do not negate his suggestions and it seems very probable that the New England

Arch was active in the Upper Carboniferous, at least north of the latitude of Woodsreef.

Folding west of the Peel Fault must postdate the Ironbark Creek Arenite, which is affected by the one deformation recognizable in the area. Thus the tectonic boundary now marked by the fault must have been an important palaeogeographic division well before the onset of folding and probably of faulting in the area. The eastern boundary of the Lower Permian land mass in Western New England must have been close to the Peel Fault, and the development of the adjacent tectonic high probably started as early as the Upper Carboniferous, before volcanic activity farther west had completely ceased.

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